THE LEUCOCYTE COUNT IN SURGERY.[1]

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THE pathology of leucocytosis is as yet in a chaotic state. Where an increase in the number of leucocytes is found in the blood, some hold that the number of leucocytes in the body has been increased, while others hold that there is no increased production, but that a greater number has found its way into the circulating blood. Even the normal site of origin of certain leucocytes is still an open question. Some regard the bone-marrow as the source of all forms of leucocytes, while others cling to the view that the lymphocytes originate in the lymph glands and lymphoid tissues. Though the pathology is so uncertain, enough has been established empirically to make the leucocyte count of great value to the surgeon.

In weighing the significance of a leucocyte count, regard must be had to certain influences which cause it to vary. One of these is the digestion of proteid substances. While the usual count in a healthy adult is from 5500 to 7000 per cubic millimetre, a few hours after a hearty dinner the count may normally be from 10,000 to 13,000. There are, however, exceptions; some individuals show little or no digestive leucocytosis. Age also has an influence; during the first few years of life a count of 10,000 to 12,000 is not abnormal. Large hæmorrhages are usually followed by a marked leucocytosis. This is said to disappear again within a few days. It may be succeeded by an abnormally low count, such as is often found in severe anæmias not the result of hæmorrhage. In a case of severe hæmorrhage from the stomach examined four days after cessation of bleeding, I found the red corpuscles 1,100,000, hæmoglobin 25 per cent., and the leucocytes nearly 9000. They had presumably been very much higher shortly after the hæmorrhage. At five-day intervals I found the leucocyte count sank as follows: nearly 6000, a little over 4000, 2500. It then began to rise. Meanwhile the hæmoglobin showed faint increase, and the red corpuscles increased steadily about 300,000 every five days.

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After ether operation of any magnitude, the count is, as a rule, much increased. I have made counts before and after operation in eight aseptic cases. The highest count was 29,000, made two and one-half hours after operation. The next day it had dropped to 13,700. Every case examined within a few hours after operation showed a marked rise, corresponding closely with the duration of the operation. The influence of a circumcision operation on a child three years old, where the patient was under ether for only a few minutes, was so slight that the count rose only from 11,600 just before operation to 12,000 four hours after operation. The next day it was 2000 less than before operation, probably owing to the restricted diet. In some of the cases the count was made for several days following operation, and in all it showed a progressive reduction. I think we may conclude that an ether operation causes an immediate increase in the leucocyte count, and that this recedes steadily in the course of the next few days.

The influence of ether operations in septic cases, where the operation is done for the relief of the septic condition, seems to vary. In the case of a two-year-old child with tubercular finger and tuberculosis of the os calcis, with apparently acute infection, the count just before operation was 23,400. I amputated the finger and curetted the os calcis. Instead of rising, the count had dropped slightly four hours after operation. At the end of two days it had sunk to 12,-

400. In an appendicitis with abscess, the count just before operation was 12,200. An hour after operation it had risen to 14,200, and the next day had receded to 11,700. An acute cervical adenitis in an infant of seven and one-half months, with a count of 19,800 just before operation, showed the next day an increase to nearly 20,800. The following day it had dropped to 15,500, and the next to 11,600. I think we may conclude that after operations for the relief of sepsis the count will vary greatly in individual cases. Relief of the sepsis will tend to send it down, while the ether will tend to send it up. From the few cases I have examined, it seems to me that where there is already a leucocytosis from sepsis, ether has less influence to raise the count than in cases where the count before operation is normal. At all events, the effect of the ether is so evanescent that, if the case is doing well, the count should drop markedly in the course of a day or two.

On the basis of only one case, I am inclined to think that the absorption of iodoform, or the iodine liberated from it, may cause a very marked leucocytosis. The patient was a man twenty-one years old. He had had an iliopsoas abscess for several months. The pus was drawn off by aspiration and two ounces of 10 per cent. iodoform-glycerin injected. One week later I found his leucocytes 12,400. Three days after that they were 11,900. Three days later the cavity was again aspirated and five ounces of 2 per cent. iodoform-glycerin injected. The next day I found the leucocyte count had shot up to 28,300. There were no local signs of acute inflammation. The urine showed a very marked iodine reaction with chlorine water and chloroform. Later the same day the abscess was incised under cocaine and a drain put in. Cultures made at the operation failed to show any growth. The following day the leucocyte count had dropped to 13,800. One case is not enough to prove anything, but the presumption is that the absorption of iodoform or iodine may cause a very marked leucocytosis.

So much for leucocytoses which may be expected to result from surgical procedures.

Carcinomata apparently have a tendency to increase the leucocyte count. This does not, however, seem to apply to the early stages when a significant count would be of value. Carcinomata which are growing rapidly or producing metastases are reported to produce, as a rule, a distinct leucocytosis. But the rule has too many exceptions to make it of much value. I have made counts in three cancer cases. An inoperable medullary cancer of the breast showed 7900. A recurrent cancer of the breast showed 11,950. An inoperable cancer of the cervix with surrounding infiltration showed 7900. These counts show only a slight upward tendency from the normal, and all were somewhat exposed to infection from ulceration.

Some interest attaches to cancer of the stomach. Many observers have noted an abscess of the digestion leucocytosis in cases of cancer of the stomach. Cabot reports that out of thirty-seven cases examined at the Massachusetts General Hospital only three showed any digestion leucocytosis. Other writers furnish figures in harmony with these. I have examined but one case. After a hearty meal the count rose from 5929 to 6538, an increase of only 609; whereas the usual digestion increase is several thousands. As a diagnostic sign, however, the failure of digestion leucocytosis is of only secondary value; for it often fails in chronic gastritis, in dilatation of the stomach, and sometimes in people of sound health. In gastric ulcer, digestion leucocytosis is usually present. Finding it would rule in favor of ulcer and against cancer.

Sarcomata are nearly always accompanied by a well-marked leucocytosis. In most cases the increase is in the polymorphonuclear neutrophiles; but Dieballa reports a case of multiple sarcoma beneath the skin where repeated differential counts showed over 9 per cent. of lymphocytes. The leucocytosis varied between 20,000 and 34,000.

The best service which the leucocyte count renders the surgeon is in the diagnosis of acute inflammatory conditions. Let me instance a few cases with their leucocytoses: Streptococcus adenitis in a seven and one-half months' infant, 19,800.

Mastoid abscesss in a six months' infant, 24,800. Circumscribed pneumococcus empyema in an eighteen months' boy, 18,900; two days later 20,500, when I operated. Cellulitis of hand and forearm in an adult, drainage insufficient, 17,400. Cervical abscess and cellulitis of leg in an adult, 17,500. Indolent ostitis of tibia with sinus in an adult, 16,900. Necrosis of upper jaw, 18,800. In this case there was profound anæmia, hæmoglobin 30 per cent., red corpuscles 1,191,000. This anæmia did not hinder the leucocytosis. Appendicitis 17,000, rising next day to 19,000. At operation, appendix partly gangrenous. The above instances are typical of the counts in pus cases which are relieved by early interference.

In most cases, other influences being excluded, the leucocyte count is a safe guide to the presence of acute suppuration; but in some instances the count is not strikingly high. In such cases I would emphasize the importance of making two or more counts at intervals to determine whether the tendency is upward or not. In the early stage of appendicitis, a stationary or downward tendency may point to the advisability of delaying interference to a period of quiescence; while a mounting leucocytosis may be the only, and a sufficient, reason for operating. A post-operative appendicitis case which I followed showed well the meaning of a progressive rise in the count. The day after operation the leucocytes numbered 11,700. The following days they were successively 14,500, 16,900, 22,100. Meanwhile the dressings, temperature, pulse, and respiration gave no distinct indication of anything wrong. At the next dressing a large quantity of pus found its way into the wound. Unfortunately, I was not able to make any further counts in the case.

Perplexing instances arise where, in the presence of severe suppuration, there is no leucocytosis. This happens usually in patients who are greatly prostrated, either by the sepsis itself or from other causes. In cases of great prostration, an absence of leucocytosis does not exclude the possibility of sepsis, and a negative count should simply be left out of the reckoning. But though the count fail us here, the quality of the leucocytes may prove of diagnostic value.

The leucocytes may help us to infer the presence of a suppurative process not only by their greater abundance, but also by qualitative changes which they exhibit. In cases where a progressive suppurative process is present, a larger or smaller proportion of the polymorphonuclear neutrophiles stain with iodine. This reaction is not found in normal blood, and is said not to occur in any diseases which could well be confounded with acute abscess.

This subject has been investigated during the last few years, notably by Livierato and by Goldberger and Weiss. Their results are harmonious. The procedure is not too difficult to be clinically available. As the leucocyte count is in some pus cases so low as to throw no light upon the presence of suppuration, this other means of determining its presence may prove of the greatest value. The technique is as follows: Cover-glass smears of the blood are prepared in the usual manner and allowed to dry spontaneously. The staining fluid consists of iodine one part; potassium iodide, three parts; water, 100 parts; gum arabic sufficient to produce a syrup-like consistency. Two or three drops of this are placed on a slide, the cover-glass floated on it, and after a few moments the excess of fluid withdrawn by a bit of filter-paper applied at an edge of the cover. The specimen is then ready for examination by an immersion lens. Air-dried blood smears retain their susceptibility to iodine for several weeks.

The red corpuscles have a dark yellow color; in normal blood all of the leucocytes are much lighter than the reds. In the blood of progressive suppurative cases, the protoplasm of a certain proportion of the polymorphonuclear neutrophiles takes on a reddish-brown coloration. The mode of coloration differs in different leucocytes: in some it is a diffuse stain; in some a granular net-work; while in others the color is confined to large or small refractive granules, varying in tint from a light pink to a dark red. The intensity of the reaction is said to be closely related to the acuteness of the pus process, being most intense in rapidly progressive streptococcus and staphylococcus phlegmons. The size of the abscess is, however, of little influence; very small abscesses may give a distinct reaction. In tubercular abscesses the reaction is absent. Acute abscesses which are well walled off and have assumed an indolent course rarely give a reaction. If, however, such a process lights up again, the iodine reaction will return. Goldberger and Weiss, from an examination of a considerable number of cases of other diseases as well as of abscess, reach the conclusion that a distinct intracellular iodine reaction, even if made out in only a few leucocytes, warrants the conclusion that there is a progressive suppurative process. Such a conclusion does not, however, hold in the presence of pneumonia, for they and other observers have found the reaction constant during the progress of lobar pneumonia. Still further reservations must be made in view of observations by Hofbauer at Neusser's clinic in Vienna, published only last month. He found that in certain grave blood diseases the iodine reaction was present. In seventeen cases of chlorosis he failed to find it. In eighteen cases of secondary anæmia he found it in two, but one was complicated by pyothorax and the other by gonorrhœal adnexa. In really grave anæmias, however, as in that associated with cancer of the stomach, severe chronic intoxications, etc., where the blood picture approached that of pernicious anæmia, he regularly found a greater or less number of iodophile leucocytes in the seven cases he examined. In advanced pernicious anæmia and in leukæmia he also found it. Hofbauer concludes, therefore, that where intracellular iodine reaction is present, before the diagnosis of a progressive suppuration can be established, the presence not only of pneumonia, but also of grave blood diseases, must be considered. His findings do not seem to me to lessen the practical value of this test.

Besides the intracellular iodine reaction there is also an extracellular reaction. This shows itself by the staining of granules of various sizes which are usually enclosed in masses of yellowish *débris*. These extracellular granules occur sparingly in normal blood. Where the intracellular reaction occurs, these extracellular granules are usually increased; but after fractures, extensive bone operations and contusions with hæmatomata, a great increase is found of the extracellular forms alone. These appear in from six to forty-eight hours and vanish in a day or two more. Later, a moderate intracellular reaction has sometimes been observed, but only where there was an accompanying fever.

This iodine reaction can be readily seen in smears of pus. The protoplasm of some of the leucocytes takes the red-brown coloration, a large proportion of them contain the refractive red-brown granules, and the field is often strewn with such granules lying outside the cells. My own observations with this test lead me to feel that a thorough trial should be made of its value to the surgeon. Let me instance two cases.

D. K., aged seven and one-half months; adenitis of neck; symptoms not acute. There was no history, and at first I thought the gland tubercular. Leucocytes 19,700. Iodine reaction very striking in some leucocytes. At operation, I found the gland had broken posteriorly, and my finger passed in the pus cavity between the spine and the top of the trachea. Pus showed streptococci.

A. M., aged thirteen years; appendicitis. Right iliac pain for five days. Leucocytes only 12,200. Iodine test shows diffuse staining of many leucocytes, a few contain brilliant iodophile granules. At operation a considerable amount of pus was found. Here the leucocytosis was low, but the iodine reaction pointed to pus, which was found at operation three hours later.

A question of special interest is this: In those cases of severe suppuration where leucocytosis fails, will the iodine reaction be present? If so, it will be an invaluable aid to diagnosis in certain critical cases. I have placed beneath microscopes examples of the various forms of iodine reaction. The first specimen shows polymorphonuclear neutrophiles in normal blood. The second is blood from a case of circumscribed pneumococcus empyema. It shows an eosinophile, unstained; a polymorphonuclear which is barely tinged, and another rather deeply stained. The third is from a case of streptococcus cellulitis with abscess. It shows a leucocyte with diffuse browning of the protoplasm. The fourth is from an appendicitis with abscess, and shows a red-brown granular net-work in the protoplasm. The fifth is from a lobar pneumonia, and shows a large extracellular iodophile granule. The sixth is from an acute tenosinovitis and cellulitis of the hand and forearm. It shows several refractive iodophile granules in the protoplasm.

A few words as to the technique of blood-counting may not be out of place. I have used the Thoma-Zeiss instrument. After use, the mixing pipette should be cleansed by drawing up distilled water three times, alcohol three times, and ether three times. Sucking air through will evaporate the last traces of ether and leave the pipette clean. The counting-chamber and cover-glass should be washed with water and polished with a handkerchief. The cover may be further cleaned with alcohol, but no alcohol should be used on the slide for fear of injuring the cement. After drawing up the blood and diluting fluid, I shake the pipette one hundred times to insure thorough mixing. About a third of the fluid is expelled and the tip of the pipette wiped before placing the drop upon the slide. Slide and cover must be so spotlessly clean that slight pressure will cause iridescence wherever they touch, and this iridescence should remain when the pressure is removed. I am in the habit of cleaning both slide and cover and inclining them, bottom up, against some object before drawing the blood, in order that there may be the least possible delay in getting the mixed blood upon the slide and the cover applied. Where only the four hundred squares in the chamber are counted, even with careful work the errors may be considerable. I make it a practice to count also the area included in the outlying parallel lines, having determined by means of a micrometer eye-piece and micrometer slide the size of this area in terms of a small square. In my instrument, the four hundred small squares, together with the outlying areas included in the parallel lines, are the equivalent of 1970 small squares. I have found it convenient to determine the factor which multiplied by the number of leucocytes counted will give at once the number of leucocytes per cubic millimetre. I use by preference a one-tenth dilution, and for this the factor is 20.3045.

In conclusion, I would lay particular stress upon this: that although the leucocyte count may be made by some one else, yet the bearing of this count upon the case in hand should be interpreted by the surgeon in charge. As the findings of the thermometer taken by themselves give no specific information, so it is with this mode of examination.

I have spoken of some of the many influences which may modify the leucocyte count. Only he who is best informed as to all aspects of the case can give to the count its due place in the diagnosis or prognosis.